

USNO Analysis Center for Source Structure Report

Alan L. Fey, David A. Boboltz, Roopesh Ojha, Ralph A. Gaume, Kerry A. Kingham

Abstract

This report summarizes the activities of the United States Naval Observatory Analysis Center for Source Structure for calendar year 2009. VLBA RDV experiments RDV71 and RDV73 were calibrated and imaged. Images from these two experiments, together with images from RDV25 were added to the USNO Radio Reference Frame Image Database. VLBA high frequency (K/Q-band) experiment BL151a was calibrated and imaged. A Southern Hemisphere imaging and astrometry program for maintenance of the ICRF continued. Activities planned for the year 2010 include continued imaging of ICRF sources at standard and higher frequencies and continued analysis of source structure and its variation.

1. Analysis Center Operation

The Analysis Center for Source Structure is supported and operated by the United States Naval Observatory (USNO). The charter of the Analysis Center is to provide products directly related to the IVS determination of the “definition and maintenance of the celestial reference frame.” These include, primarily, radio frequency images of ICRF sources, intrinsic structure models derived from the radio images, and an assessment of the astrometric quality of the ICRF sources based on their intrinsic structure.

The Web server for the Analysis Center is hosted by the USNO and can be accessed by pointing your browser to

http://rorf.usno.navy.mil/ivs_saac/

The primary service of the Analysis Center is the Radio Reference Frame Image Database (RRFID), a Web accessible database of radio frequency images of ICRF sources. The RRFID contains 6,747 Very Long Baseline Array (VLBA) images (an 8.3% increase over the previous year) of 711 sources (a 3.8% increase over the previous year) at radio frequencies of 2.3 GHz and 8.4 GHz. Additionally, the RRFID contains 1519 images (a 13% percent increase over the previous year) of 280 sources (a 2.2% increase over the previous year) at frequencies of 24 GHz and 43 GHz. The RRFID can be accessed from the Analysis Center Web page or directly at

<http://rorf.usno.navy.mil/rrfid.shtml>

The RRFID also contains 74 images of 69 Southern Hemisphere ICRF sources using the Australian Long Baseline Array (LBA) at a radio frequency of 8.4 GHz. Images of ICRF sources can also be obtained from the Bordeaux VLBI Image Database (BVID) at

<http://www.obs.u-bordeaux1.fr/m2a/BVID/>

Shown in Figure 1 is the distribution of the mean structure index for 707 sources with VLBI images available from the RRFID and the BVID. These data and analysis were directly involved in the selection of the defining sources for the second realization of the International Celestial Reference Frame (ICRF2; <http://www.iers.org/MainDisp.csl?pid=46-1100252>).

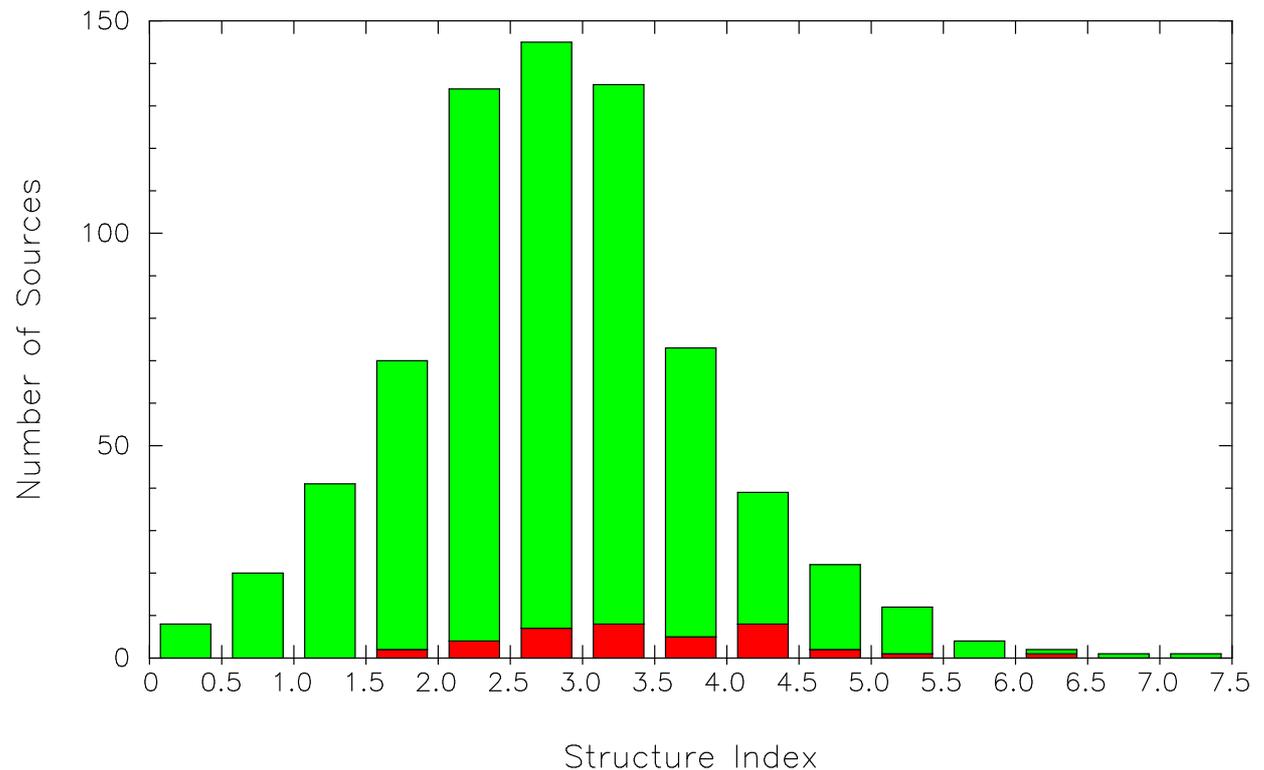


Figure 1. Distribution of the mean structure index for 707 radio sources with VLBI images available from the USNO Radio Reference Frame Image Database or Bordeaux VLBI Image Database. The 39 special handling sources discussed in IERS Technical Note 35 are color-coded in red.

2. Current Activities

2.1. VLBA Imaging

Very Long Baseline Array (VLBA) observations for maintenance of the celestial and terrestrial reference frames have been carried out since about 1994. Since 1997, these VLBA RDV observations have been part of a joint program between the USNO, the Goddard Space Flight Center (GSFC) and the National Radio Astronomy Observatory (NRAO). During each 24 hour VLBA RDV session, about 100 ICRF sources are observed at S/X-band (2.3/8.4 GHz) using the VLBA, together with up to 10 additional geodetic antennas. Images are produced from these observations and made available through the RRFID.

VLBA experiment RDV73 (2009JAN21) was calibrated and imaged, adding 175 (87 S-band; 88 X-band) images to the RRFID, including images of 23 sources (0035-252, 0043-268, 0055-059, 0420+022, 0502-152, 0515+208, 0529+483, 0532-378, 0632-235, 0741-444, 0847-120, 0915-118, 1059-438, 1133-032, 1243-160, 1428+370, 1602-115, 1633-409, 1650-157, 1711-209, 1913-272, 2157-255, and 2220-318) not previously imaged.

VLBA experiment RDV71 (2008SEP03) was calibrated and imaged, adding 168 (84 S-band; 84 X-band) images to the RRFID.

VLBA experiment RDV25 (2001JAN29) was calibrated and imaged, adding 175 (87 S-band;

88 X-band) images to the RRFID, including images of two sources (1604-333 and 2312-319) not previously imaged. These results were contributed by Glenn Piner and Christopher Marvin of Whittier College, who calibrated, edited, and imaged the data.

Collaborations continue with Glenn Piner at Whittier College and Patrick Charlot of Bordeaux University to calibrate and image several of the VLBA RDV experiments.

2.2. VLBA High Frequency Imaging

VLBA observations to extend the ICRF to 24 and 43 GHz continued in 2009. These observations are part of a joint program between the National Aeronautics and Space Administration, the USNO, the National Radio Astronomy Observatory (NRAO), and Bordeaux Observatory. During the calendar year 2009 two papers, submitted for publication in the *Astronomical Journal*, were revised: 1) “The Celestial Reference Frame at 24 and 43 GHz. I. Astrometry” by Lanyi et al. and 2) “The Celestial Reference Frame at 24 and 43 GHz. II. Imaging” by Charlot et al.

VLBA high frequency experiment BL151a was calibrated and imaged, adding 180 images at 24 GHz to the RRFID.

2.3. ICRF Maintenance in the Southern Hemisphere

The USNO and the Australia Telescope National Facility (ATNF) continue a collaborative program of VLBI research on Southern Hemisphere source imaging and astrometry using USNO, ATNF, and ATNF-accessible facilities. These observations are aimed specifically toward improvement of the ICRF in the Southern Hemisphere. One celestial reference frame experiment, CRFS13, was scheduled with antennas at Hobart, Australia and the 70-meter Deep Space Network antenna at Tidbinbilla, Australia.

A program to monitor the structure of quasars south of declination -30° that are either known to be gamma-ray loud or are expected to be gamma-ray loud continued. The program, called TANAMI (Tracking Active galactic Nuclei with Australia Milliarcsecond Interferometry), is observing a sample of about 75 quasars at 8 GHz and 24 GHz bands, with about a third of the sample observed every two months.

3. Staff

The staff of the Analysis Center is drawn from individuals who work at the USNO. The staff are Alan L. Fey, David A. Boboltz, Roopesh Ojha, Ralph A. Gaume, and Kerry A. Kingham.

4. Future Activities

The Analysis Center currently has a program of active research investigating the effects of intrinsic source structure on astrometric position determination. Results of this program are published in the scientific literature.

The following activities for 2010 are planned:

- Continue imaging and analysis of VLBA 2.3/8.4/24/43 GHz experiments
- Make additional astrometric and imaging observations in the Southern Hemisphere in collaboration with ATNF partners and the TANAMI program team.

5. Relevant Publications

Publications of relevance to Analysis Center activities are:

- “The Second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry”, Presented on behalf of the IERS / IVS Working Group, Alan Fey, David Gordon and Christopher S. Jacobs (eds.). (IERS Technical Note ; 35) Frankfurt am Main: Verlag des Bundesamts für Kartographie und Geodäsie, 2009. 204 p., in print;
<http://www.iers.org/MainDisp.csl?pid=46-1100252>
- “TANAMI: Milliarsecond Resolution Observations of Extragalactic Gamma-ray Sources,” Ojha et al. 2009 Fermi Symposium, eConf Proceedings C091122;
<http://arxiv.org/abs/1001.0059>